

## **Developing Iowa's Bioscience Workforce**

### **An Overview of the Efforts of Iowa's Community Colleges to Train Skilled Workers for the Emerging Bioscience/Biotechnology Sector**

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The Iowan economy is undergoing great change and without a well-educated, skilled workforce taking advantage of new technologies, it will not fare as well in the “new” knowledge-driven economy. As traditional manufacturing employment decreases in importance with globalization, economic development officials have targeted higher growth sectors. Among the sectors deemed important to Iowa’s economic future is bioscience. A report by Battelle (Iowa’s Bioscience Pathway for Development) notes there is no commonly accepted definition of what constitutes the bioscience sector but suggests it includes agricultural, medical, plant-life sciences, and related industrial activity.<sup>1</sup>

Since the value of skills is paramount in the innovation and knowledge economy, higher education institutions play a pivotal role.<sup>2</sup> While often this is perceived as involving only four-year institutions, the pre-baccalaureate level is critical in training and retraining the bulk of the workforce for high value added employment. The importance of community colleges in this effort cannot be understated given the state’s high retention rates of graduates relative to Regents and private four-year institutions.<sup>3</sup> Community colleges’ accessibility (they are open to everyone and located near where students live), flexibility, and relatively low cost put them in a unique position to train or retrain most workers for an increasingly competitive global market.<sup>4</sup>

With regard to biosciences, the Bioscience Pathway for Development report noted that Iowa has the opportunity to build a world-class technical workforce that will provide it with an advantage in attracting and retaining bioscience companies.<sup>5</sup> Production level talent and technicians will be critical to sustain the growth of skill-intensive bioscience businesses (a sizeable percentage of bioscience companies’ positions are pre-baccalaureate).<sup>6</sup> The rapidly evolving nature of bioscience industries makes community colleges, which are designed to quickly respond to changing economic needs, an essential part of the multi-tiered workforce development process.<sup>7</sup> Among Battelle’s recommendations was the development of a bioscience vocational career education program and articulation agreements between various levels of bioscience education.<sup>8</sup>

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<sup>1</sup> “Iowa’s Bioscience Pathway for Development” Battelle Technology Partnership Practice. July 2004. Available online at: <http://www.iowalifechanging.com/downloads/IowaStrategicReport704.pdf>

<sup>2</sup> “The 21<sup>st</sup> Century at Work: Forces Shaping the Future Workforce and Workplace in the United States.” Lynn Karoly and Constantijn Panis. Rand Labor and Population. Available online at: [http://www.rand.org/pubs/monographs/2004/RAND\\_MG164.pdf](http://www.rand.org/pubs/monographs/2004/RAND_MG164.pdf)

<sup>3</sup> “Putting It All Together” Kelly, Patrick. National Center for Higher Education Management Systems (NCHEMS). May 5, 2005. Available online at: <http://www.state.ia.us/educate/ccwp/cc/reports/implications.pdf>

Also, more students attend community colleges than the four year Regent’s institutions.

<sup>4</sup> A series of articles by A. Stephen Dahms highlights the role of community colleges in training and retraining the biotechnology workforce. These articles can be found in the journal Biochemistry and Molecular Biology Education. Available online at: <http://www.bambled.org/cgi/content/full/31/5/346>

<sup>5</sup> Battelle.

<sup>6</sup> Two-thirds of biomanufacturing employees have less than a baccalaureate degree.

Window on the Workplace 2003. A Training Needs Assessment for the Biomanufacturing Workforce. North Carolina Biotechnology Center Education and Training Program. March 2003.

<sup>7</sup> Dahms.

<sup>8</sup> Battelle.

Community colleges in Iowa have each developed different programs to train people within their merged areas for changes in the economy. Some have focused on bioscience and related fields more than others. This document comprises a short, non-exhaustive list of community college bioscience programs and offerings.

Among the principal challenges with compiling such an inventory relates to program classification. It is unclear exactly what the amorphous concept called “bioscience” entails. The dictionary definition of bioscience is “any of the branches of natural science dealing with the structure and behavior of living organisms.”<sup>9</sup> The Battelle report implies that virtually all plant, animal and human (health/medical) sciences and related industrial activity are included.<sup>10</sup> However, such definitions are not particularly useful for our purposes because of their inherent ambiguity and broad scope. It may make sense to limit the discussion of community college bioscience programs by filtering out some traditional nursing, agricultural, and industrial programs -- possibly by emphasizing biotechnology. However, some “life science” programs not considered in the field of “biotechnology” are also relevant (e.g. medical equipment programs). The problem is determining exactly where to draw the line – clearly there will be overlap. Depending on the course offerings of a given program, a program may or may not be “bioscience-related.” For example, quality control programs might be considered “bioscience” or they might be related only to “traditional” manufacturing. Part of the answer to these issues lies in the curriculum and what skills students are learning. Agricultural programs that teach animal/plant breeding techniques may be defined as biotechnology, however, many agriculture programs (e.g. viticulture) might not be. The Department of Labor’s Career Voyages website lists community college biotechnology programs in Iowa (although very incomplete) and includes conservation technology and natural resources management programs. The curricula of these programs do not appear to be grounded in biotechnology nor do they require much in the way of general science courses (most would argue that roadside vegetation management is not a “bioscience” or “biotechnology” skill).<sup>11</sup> The Battelle report suggests the focus should be on six emerging technology platforms including bioeconomy (e.g. biofuels), advanced food products (e.g. nutraceuticals), animal systems, integrated biosecurity, and pharmaceutical/post-genomic medicine.<sup>12</sup> Perhaps the focus should be on programs related to serving the workforce needs of these emerging industries. However, the Biotechnology Institute separates modern (e.g. manipulation of genes) and traditional (e.g. fermentation) biotechnology, suggesting that the former has greater potential and raising additional questions regarding any ad hoc definition.<sup>13</sup>

Regardless of the definition, the efforts of some community colleges stand out. Several community colleges have developed programs that are explicitly designed to meet the growing need for biotechnology-related technical workers. Many have partnered with local bioscience industries to better train workers for emerging high tech

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<sup>9</sup> Definition listed on [www.dictionary.com](http://www.dictionary.com) (Worldnet, Princeton University).

<sup>10</sup> Battelle.

<sup>11</sup> U.S. Department of Labor Career Voyages website. Available online at: <http://www.careervoyages.gov/biotechnology-commcollegesws.cfm>

<sup>12</sup> Battelle.

<sup>13</sup> Biotechnology Institute website. Available online at: [www.biotechinstitute.org/what\\_is/](http://www.biotechinstitute.org/what_is/)

vocations. Others have partnered with area high schools (forming career academies or offering short courses) to spur students' interest and provide skills in bioscience fields.

Several of the colleges have designed their programs specifically to meet the needs of companies within their districts. For example, Indian Hills Community College (IHCC) has created a bioprocess technology program to meet the needs of Cargill and other area companies. Similarly, Iowa Lakes Community College (ILCC) has developed biomass energy processing and sustainable energy resources management programs specifically designed to meet the growing need for ethanol and bio-diesel production workers and managers. Given the diverse nature of bioscience industries, community colleges' programs vary considerably depending on what types of industries are located within their districts. Iowa Central Community College (ICCC) offers an industrial laboratory technician program to meet the needs of Fort Dodge Animal Health and other pharmaceutical companies. The program emphasizes Good Manufacturing Procedures (GMP) and Good Laboratory Procedures (GLP) that are important to the pharmaceutical industry (rather than fermentation processes important to bio-fuel industries).<sup>14</sup>

However, while the programs are catered to local industries, most two-year technician programs labeled "biotechnology," "bioprocess," or "industrial laboratory" have at their core a similar base of academic courses (e.g. biology I and II, chemistry I and II, microbiology, molecular biology, organic chemistry or biochemistry, and genetics in addition to basic English/math general education courses). While there is some variation, the science background offered with these programs appears similar. The variation that does exist is partially related to variation in local industry needs (e.g. Western Iowa Technical Community College's biotechnology program emphasizes molecular biology because of protein/gene research in the Sioux City area). Individual programs also vary in the proportion of credit hours earmarked for science background courses and applied technical courses. While IHCC's bioprocess technology program is very industry-oriented with a high percentage of courses designed to provide technical skills (no biology II or chemistry II and most science courses are "applied" science), Des Moines Area Community College's (DMACC) biotechnology program appears to have a high percentage of credit hours earmarked for courses designed to teach scientific principles (with fewer courses for hands-on technical skills such as equipment maintenance).

Most of the variation between programs appears to be in the content of required technical courses. For instance, WITCC's program includes a pair of four credit biotechnology courses that focus on genomics and proteomics. ICCC's program includes a pair of biotechnology methods courses focusing on laboratory methods and GMP/GLC regulations (though industrial processes such as fermentation are also discussed). The bioprocess technology program at IHCC is the most industry-oriented with courses in ethanol/bacterial/fungal fermentation, quality management, process control, and industrial maintenance. Of course, bioscience-related certificate programs involve less coursework (in both science and technical areas) than associate degree programs.

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<sup>14</sup> Information about individual community college's bioscience-related programs, efforts and happenings were collected from college websites, Iowa Dept. of Education Shaping the Future Report (available online at: <http://www.state.ia.us/educate/ccwp/cc/reports/stf04.pdf>), IHCC pamphlets and other literature, and correspondence with deans/program coordinators involved with bioscience-related programs at individual community colleges.

The programs also vary in the area of work-based learning components. While some programs are entirely school-based and do not require internships (e.g. WITCC's biotechnology AS program), others require a large portion of total credit hours to be spent on training at local companies. Ellsworth Community College's (Iowa Valley Community College District) biotechnology program includes 15 credits of co-op field experience (supervised on the job training). Other AS programs appear to have about 3-4 credits earmarked for internships in their fourth semesters (e.g. DMACC's biotechnology AS program).

In addition to credit programs, community colleges are also offering noncredit training (or retraining) to workers in emerging biotech industries. For example, IHCC offers partial day and multi-day workshops on a variety of industrial biotechnology topics at the Iowa Bioprocess Training Center in Eddyville. Iowa BioDevelopment (an IHCC outreach program) offers area industries customized needs assessments, job analyses, and training programs.

It appears important that workers be trained for positions likely to become available in their area and that the size of credit biotechnology programs (in terms of enrollment) not greatly exceed projections for industry needs. While many skills students receive are transferable to other related sectors (e.g. chemical processing/manufacturing), some may not be. If there are not expected to be biotechnology-related jobs in a given area, it may not make sense for colleges (especially small ones) to invest in expensive two-year biotechnology AS or AAS programs.<sup>15</sup> A July 2004 statewide biotech training needs assessment completed by IHCC for the Iowa Department of Economic Development found that in more than half of the community college districts there was only one biotech company or none whatsoever.<sup>16</sup> The Battelle report notes that "a critical mass of customers is needed to justify the investment [into a customized bioscience vocational program]."<sup>17</sup> Instead, it may be appropriate for these colleges to offer biology/chemistry programs designed for transferring to four-year institutions or "shared" programs with other community colleges. It may also be appropriate for certain colleges to become bioscience hubs (training technicians for the industry or providing additional training to individuals with baccalaureate degrees needing practical/hands-on experience) while others focus on other potentially emerging industries within their districts. The Battelle report seems to support such an arrangement stating community college students

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<sup>15</sup> Dahms. (specifically "Commentary: Industrial Biotechnology Education: A Model of Collaboration between Industry and Academia). Dahms suggests such programs are only warranted in industry clusters and even then with only 10-30 graduates each year. He also argues that significant industry support in the form of donated equipment, management time, and facilities is required.

"Signs of Life: The Growth of Biotechnology Centers in the U.S." Joseph Cortright and Heike Mayer. The Brookings Institution Center on Urban and Metropolitan Policy. Available online at: <http://www.brookings.edu/dybdocroot/es/urban/publications/biotech.pdf>

<sup>16</sup> The 50-company biotech training needs assessment was completed by IHCC for the Iowa Department of Economic Development. However, the methods used in the survey involved community colleges reporting biotech companies within their areas. Some community colleges did not report or underreported (e.g. ICC had reported no biotech companies within their merged area but the Iowa Biotechnology Association reports companies such as Wyeth division and veterinary pharmaceutical maker Ft Dodge Animal Health is located there) and many companies opted not to participate. Additionally, no attempt was made to project future training needs (the presumption is that the industry is growing).

<sup>17</sup> Battelle.

could learn general coursework at their host college then transfer to the Eddyville Biotech Training Center for more complex core courses.<sup>18</sup> In the future, it is likely community colleges will partner with each other to offer their students access to various bioscience programs (possibly following an IHCC model). It may be possible to further expand IHCC's pilot program to other areas of the state with three to five community colleges acting as bioscience hubs and partnering with the remaining 10-12 colleges. Each hub could potentially focus on specific bioscience/biotechnology fields.<sup>19</sup> Community colleges may also wish to investigate reciprocal agreements with similar institutions in adjacent states (such as Southeastern Community College does to offer Iowa students opportunities in medical imaging programs offered at an Illinois community college).

This highlights the importance of partnerships. The community colleges with biotechnology-related programs appear to have partnered closely with local industry for curriculum development and internships. For instance, DMACC partners with seven companies for its biotechnology program and ICCC's industrial laboratory technician program has a close relationship with Fort Dodge Animal Health. The active participation of industry in work preparation programs allows educators to better meet industry needs and enhances the competitiveness of graduates in the labor market.<sup>20</sup>

The colleges also have begun partnering with area high schools as suggested by the Battelle report.<sup>21</sup> Kirkwood Community College is creating science-oriented Career Edge academies in five high schools. Hawkeye Community College (HCC) is working to develop a 2+2 biotechnology career academy with area high schools. One barrier to the creation of career academies appears to be the need for high school instructors to have advanced degrees in their field for program articulation. Since bioscience degree holders are already in high demand, finding instructors with advanced degrees will be challenging.<sup>22</sup> DMACC, ICCC and WITCC have also made attempts to reach out to high school students to spur their interest in biotechnology and related industries.

It seems possible for community colleges to increase bioscience-related professional development opportunities to high school science teachers as well.<sup>23</sup> EICC has offered several biotech workshops in cooperation with ISU faculty and Monsanto. IHCC partners with its local area education agency (AEA) to provide fermentation-related bioprocess workshops for high school educators. DMACC has provided biotechnology teacher workshops in conjunction with Project SEMI. DMACC Biotechnology Program Chair Jane Bradley said that while few community colleges offer professional development opportunities to K-12 teachers, many colleges are interested and willing to provide the service. Because of the high cost of laboratory space and equipment, community colleges might better serve teachers' (particularly high school

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<sup>18</sup> IHCC is currently working on putting together the "shared" program.

<sup>19</sup> For example, one bioscience hub could focus on bioprocessing while another could focus on the substantively different training needs of pharmaceutical manufacturers. The Biotech Training Needs Assessment confirms that there is significant variation in the training needs of the state's diverse group of biotech companies.

<sup>20</sup> Dahms.

<sup>21</sup> Battelle.

<sup>22</sup> A program designed to encourage high school biology/chemistry teachers to get masters degrees would be valuable.

<sup>23</sup> The Biotech Training Needs Assessment report recommended increasing the number of biotechnology professional development opportunities for K-12 teachers.

science teachers) professional development needs in this area than other institutions. The distribution of community colleges throughout the state may make it easy for teachers to access workshops and other opportunities. The potential also exists for community colleges to work with high school guidance counselors to highlight emerging bioscience career paths (helping to fill a gap cited by the Iowa Biotechnology Association). IHCC and DMACC have already begun making progress in this area.<sup>24</sup>

Partnerships are also growing between community colleges and the state's public four-year universities. Some of the biotechnology-related associate degree programs and many courses of other programs are transferable to four-year institutions. For example, DMACC's biotechnology program is articulated with UNI's biotechnology B.A. program (a 2+2 arrangement). The Battelle report suggests the eventual goal should be seamless 2+2+2 programs (integrated from high school, through two year programs, to baccalaureate programs).<sup>25</sup> HCC appears to be heading in this direction with plans for biotech career academies, a biotechnology AS degree program, and articulation of the two-year program with UNI's biotechnology program. The new biotechnology program at UNI appears to be the best starting point for articulation of most community college biotech-related programs, however many program coordinators and deans are not aware of its existence. Additionally, given the highly practical nature of some courses (and skills required by local industries), articulation may not always be possible with all institutions and programs. UNI Biology Department Head Barbara Hetrick reported that more standardized programs such as DMACC's biotechnology program are easier to articulate than programs tailored to specific jobs such as the bioprocessing program at IHCC. In cases where articulation is problematic, as many courses as possible should be articulated (especially general science courses). However, as program and course articulation is improved, it appears critical that community colleges make certain transferable courses are as rigorous as the same courses at Regents' universities (so students entering challenging four-year science programs are not under-prepared).

A small number of community colleges may also wish to consider beginning to recruit recent graduates of four-year biology and chemistry programs for short post-baccalaureate certificate programs. Often recent four-year graduates lack on-the-job skills and are unable to meet employers' needs. These graduates sometimes become unemployed or underemployed or change careers entirely. This had led a number of community colleges in other states to form "baccalaureate retread" training programs.<sup>26</sup> These continuing education programs are often short industry-oriented certificate programs (designed to provide practical training) and can also be used to meet area industries' retraining needs.

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<sup>24</sup> IHCC's workforce training needs assessment.

<sup>25</sup> Battelle.

<sup>26</sup> Dahms.

The biotech workforce needs assessment recommended that community colleges begin actively recruiting underemployed four-year college graduates for biotech-related certificate programs.

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## **Summary of each community college's bioscience-related programs and efforts<sup>27</sup>**

**Indian Hills Community College (IHCC)** has one of the best examples of a successful bioscience-related technical degree program in the state. The college offers an articulated bioprocess technology degree (AS) program (career option and college parallel) and a 21-month ethanol plant technician (AAS) program. In the bioprocess technology program, students learn to apply scientific principles and technical skills in support of biosynthesis and fermentation in research and industrial settings (with instruction in automated process control and instrumentation technologies). The program is structured to allow students the option of taking three terms of core classes at another college before transferring to IHCC to complete the remaining four terms of the program. Jill Rossiter, assistant to the president, college/industrial relations, reported that roughly 20-25 students are enrolled in each class and 15-20 graduate annually (with greater than 95% finding employment with local biotech companies). She also noted that more women enroll in the program than men.

The ethanol plant technician program began being offered during the summer of 2005. It focuses on ethanol fermentation processes with instruction in electrical/electronics theory, process control, bioprocess lab techniques, digital fundamentals, and high level equipment maintenance and analysis. IHCC also offers a 21-credit hour process control certificate program (which is closely linked to the bioprocess technology degree program) and an online introduction to biotechnology course that may be taken by high school students for college credit.

IHCC's biotechnology programs are partially funded by a grant from the U.S. Department of Labor to develop new curriculum and training models for biotech workers. The grant was given to only five community colleges in the country as part of the "High Growth Job Training Initiative." The college completed a statewide workforce training needs assessment of 50 biotechnology/bioprocessing companies in Iowa (funded by Iowa Department of Economic Development) last year with the goal of using the data to expand training options throughout the state by offering its bioprocess technician program to other community colleges as a "shared" program.

Currently, the college is seeking funding from business and industry through Accelerated Career Education programs to further build its career and technology-based programs. It is also seeking additional federal funding to build new programs in bioprocessing (biomanufacturing technologies utilizing fermentation, cell culture, and other associated processes) and biocatalysts with the goal of being the state's premier biotechnology/bioprocessing workforce development institution.

The college operates a bioprocess training center near a Cargill facility in Eddyville and closely partners with several area bioscience companies and related industries. Utilizing a grant from the National Science Foundation and working with Iowa State University, IHCC has developed a mobile virtual reality computer system to

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<sup>27</sup> Resources used in compiling this inventory include: individual community college websites, Iowa Dept. of Education Shaping the Future Report (available online at: <http://www.state.ia.us/educate/ccwp/cc/reports/stf04.pdf>), IHCC pamphlets and other literature, and correspondence with chief academic coordinators/deans/program coordinators involved with bioscience-related programs at individual community colleges.

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assist in instructing students about fermentation and other industrial processes (and spurring high school students' interest in the field). The 12,000 square foot training facility also houses a fully functional fermentation pilot plant/training laboratory, a process control training laboratory, a bioprocess training laboratory, and an ICN classroom. During the school year, the facility hosts a number of public school field trips. Additionally, college faculty members have traveled to 15 area middle and high schools to give presentations on corn milling, DNA extraction, fermentation (using the virtual reality system), and biotechnology career opportunities. Iowa BioDevelopment Project Assistant Janet Paulson reported that the topics of future presentations would include the making of soy biodiesel, corn chemistry, DNA forensics, and more.

Through the Iowa BioDevelopment outreach program, IHCC provides statewide biotech and value added agriculture industries with affordable access to customized needs assessments and training programs. The non-credit programs (awarding continuing education units) include the industrial biotechnology continuing education program and a number of workshops ranging from a half day to five days. The workshops cover a range of topics including enzymes, introduction to molecular biology, ion-exchange chromatography, and much more. Iowa BioDevelopment has been designated as a National Center for Excellence in Biotechnology Workforce Training by the Department of Labor.

Other programs potentially of interest include AA/AS programs with biology or chemistry focus areas, pre-professional programs (e.g. pre-veterinary), water/wastewater and distribution, agriculture-related (e.g. viticulture), and health programs.

**Iowa Central Community College (ICCC)** has also attempted to address the state's strategic bioscience goals by offering a high-tech program in industrial technology to meet the needs of area value-added agricultural, biotech and advanced manufacturing industries. The industrial laboratory technician (AS) program is designed to prepare students to be entry level technicians with the knowledge and skills needed to work in vocations associated with the production of vaccines and pharmaceuticals (emphasis in microbiology and chemistry). The skills students learn (e.g. biomaterials production, quality control, and analytical testing of samples) appear similar to some of the other biotech-related programs, however, ICCC students focus on Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) which are important to pharmaceutical industries and related firms because of federal regulations. The program, now in its third year, is closely linked to Fort Dodge Animal Health with students visiting the company's facilities many times and conducting laboratory work there during their second year.<sup>28</sup> Approximately ten students were enrolled in the program during the 2004-2005 academic year.

Iowa Central is currently in the process of adding a biofuels component to the program, ICCC Math and Science Department Chair Larry Boyd reported. In about a year, ICCC is expected to begin training technicians (through a new AS program) to work in newly constructed ethanol factories and the emerging biodiesel industry. The program's curriculum is being developed with the help of several area ethanol producers. Boyd said ICCC is also discussing sharing courses (online) with Minnesota West

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<sup>28</sup> Fort Dodge Animal Health pays 90% of tuition for employees who enroll in the program.

Community and Technical College. Currently Minnesota West offers an online certificate program (renewable energy base certificate) focused on ethanol production.

ICCC has also developed an “early bird” biotechnology course to be offered as a contracted course to area high schools. While not a career academy, the course is offered at seven partnering high schools to spur students’ interest in biotechnology and raise awareness about emerging career opportunities. The course is taught by high school faculty and gives students the opportunity to earn college credit while still in high school. In the fall of 2005, this course will also be taught at Iowa Central as part of the Industrial Laboratory Technician program. Boyd said the Iowa Central is willing to share the program’s curriculum with other colleges.

Other programs potentially of interest include health programs (e.g. medical laboratory technician program) and other programs such as the conservation technology.

**Hawkeye Community College (HCC)** is currently developing an associate degree program in biotechnology with both career and college parallel options. HCC Dean of Arts and Sciences Dr. Suresh Tiwari noted the program will be unique – not targeting any specific biotech industries since very few are located within the college’s service area. The program will educate students about biotechnology fundamentals and broad-based industry-specific skills (e.g. courses in genetic engineering, polymerase chain reaction methods, bioinformatics, government regulations). Tiwari expects graduates to be prepared to work in the biotechnology industry as entry-level technicians in bioinformatics, biotechnology, and analytical protein chemistry or to transfer to baccalaureate programs in bioinformatics, biotechnology, and related fields in biology. Students will grow microbial plant, animal and mammalian cells, recover their DNA and proteins, and analyze these macromolecules while following Good Manufacturing Practices (GMP, critical to pharmaceutical manufacturers). Tiwari expects the program to be offered in the fall of 2006 if a suitable faculty member can be recruited to coordinate the program.

HCC is also planning to develop 2+2 tech. prep. programs (career academies) in biotechnology utilizing partnerships with area high schools. The academies will likely be located in Waterloo and potentially Cedar Falls modeled after the college’s information technology career academy, Tiwari noted. HCC will provide laboratory equipment (e.g. DNA extraction equipment) and professional development opportunities to school faculty.

A 2+2 articulation agreement has been completed with UNI’s biotechnology baccalaureate program giving students the option of continuing their education in Cedar Falls.<sup>29</sup> The goal is to create a seamless 2+2+2 arrangement as recommended by the Battelle report.

Additionally, HCC plans to establish a technical assistance center at the Cedar Valley Tech Works (a facility that will research, produce and showcase biotech products such as soy-based industrial lubricants developed at UNI) that will provide specialized technical assistance to biotech-related businesses in the Cedar Valley and establish an interface with Tech Works’ portal program to offer college services through “webinars.” Once complete, the Tech Works facility is expected to hire some HCC biotech graduates

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<sup>29</sup> Students take introductory science courses at UNI to ensure they receive a complete sequence of freshman and sophomore science classes, increasing the likelihood of them graduating in four years.

and provide internship opportunities for high school and college students in the area. Tiwari noted that continuing education courses and workforce development training would be offered at the facility as some college operations phase in over the next year.

Other programs potentially of interest include animal science, general science transfer, natural resources, and health programs (e.g. medical lab. technician). Tiwari noted the college is planning to expand environmental science/technology course offerings with the hope of creating an associates program within a year.

**Des Moines Area Community College (DMACC)** has partnered with its local area education agency, several area industries, many high schools, the University of Northern Iowa, and Iowa State University to expand opportunities for students in the growing biotech areas. DMACC offers a biotechnology program (AS) designed to prepare students to work as biotechnology technicians in many areas including research and development, quality control, and manufacturing. Graduates are expected to find careers requiring skills related to the genetic engineering of plants or microorganisms, gene therapy, DNA fingerprinting, vaccine development, or the production of food/drugs/consumer products. The program includes both science courses (chemistry, biology, microbiology, genetics, molecular biology) and lab-based courses. A curriculum in the growing field of proteomics is also being developed. Internships are arranged in cooperation with potential employers (which also serve on the program's advisory committee). Approximately eight students (more women than men) will graduate this summer following their internships (17 were enrolled in the program in 2004-2005). Biotechnology Program Chair Jane Bradley said she expects the program to grow but to never be very large. A 2+2 agreement with UNI's biotechnology B.A. program (and biology B.A. program) was recently completed and most credits are transferable to other four-year institutions such as ISU. DMACC is currently partnering with Indian Hills Community College and the Iowa Biotechnology Association in a Department of Labor grant.

While the college has agreements with 52 area high schools for the delivery of college credit offerings in such courses as biology, currently biotechnology is not among DMACC's eight 2+2 career advantage programs. However, college credit courses in biotechnology are offered to some high school students through a partnership between DMACC and East High School. Bradley said East High was selected with the hope of drawing minority students into the field of biotechnology. Bradley hopes programs similar to the EHS pilot can be developed at other area high schools.

DMACC has also been actively involved with Project SEMI, an effort to provide secondary education students in Iowa with biotechnology laboratory experiences (and recruit them into the sciences). DMACC has offered a series of teacher leader workshops (single-day, 3-4 hours in length) to prepare teachers to use the Project SEMI lab. The workshops have been on topics such as horizontal gel electrophoresis. DMACC partners Integrated DNA Technologies and Pioneer Hi-bred have hosted similar workshops using their own curricula.

Other programs potentially of interest include health (e.g. medical lab. technician AAS), agriculture, and forensics courses and biology/chemistry transfer courses. A veterinary technology program is also offered, designed to train technicians to provide support for veterinarians and potentially biomedical researchers. Bradley noted

DMACC's biology program has a 2+2 agreement with Drake University's pharmacy science program.

**Western Iowa Tech Community College (WITCC)** has developed a biotechnology program (AS) to serve the Siouxland area starting in the 2005-2006 academic year. The multidisciplinary program is designed to train technicians needed in the areas of medicine, pharmaceuticals, environmental science, agriculture and forensics. Students are provided with a strong science background with basic courses in general biology, microbiology, general chemistry, and organic chemistry, and specialty courses in genomics, proteomics, and bioethics. While the program is academic in orientation, students learn technical skills such as how to use lab equipment, perform tests, prepare media/reagents, calibrate/maintain equipment, maintain documentation on lab protocols/procedures, collect/analyze/report data, and perform laboratory tasks related to DNA technology and protein chemistry. Dr. Kamali Muthukrishnan, chair of the science department at WITCC, noted the program (emphasizing molecular biology) differs substantially from Indian Hill's processing-oriented bioprocess technology program (focusing on fermentation and other bioprocesses).

WITCC is currently developing a 2+2 agreement between its biotechnology AS program and UNI's four-year biotechnology program. Muthukrishnan noted the college is also developing partnerships with area high schools to offer college credit courses to their students. The college has applied for approximately \$400,000 in federal funds for bioscience lab equipment and recently received a \$49,000 grant for a DNA genetic sequencer.

A summer biotech institute (nonresidential summer camp) was held in early June for high school girls that have finished a year of high school biology and chemistry. Participants gained experience (introducing them to the field, potentially spurring their interest) in DNA extraction and fingerprinting, bacterial transformation, polymerase chain reaction, protein purification and analysis, and bioinformatics. The program was funded by a Gender Equity Grant from the Iowa Department of Education.

WITCC also offers a biomedical equipment technology career program (AAS). Students in the program are trained to interpret schematics and wiring diagrams of electronic equipment used in hospitals. Other programs potentially of interest include agri-food technology, agribusiness technology, agriculture, animal science, biology and chemistry (transfer), and health related programs.

**Iowa Valley Community College District (IVCCD)** also has created an articulated biotechnology program (AS) with career and college parallel options. Offered at Ellsworth Community College, the program was the first in the state and one of the first in the nation (created in 1985) and is today second in enrollment size only to Indian Hills' bioprocessing program. Approximately 20-40 students enroll in the program each year (a total of 43 were enrolled in 2003-2004), IVCCD Chief Academic Officer Chris Russell reported.

A one-year biotechnology practitioner diploma program is also offered providing students with the option to transfer their credits into the two-year biotechnology or laboratory technology program. Both programs are offered at the Ellsworth college. The practitioner program is designed to provide training for technicians in genetic engineering, monoclonal antibodies, tissue culture, enzymology, fermentation, and embryo transplants. The associate degree program has additional coursework and a total

of 15 credits of supervised on-the-job training. Graduates of the AS degree program may transfer to Iowa State University and major in agronomy (with a biotechnology option) or veterinary medicine or transfer to similar programs at other colleges. The college is also in the process of articulating the AS program with UNI's biotechnology BA program.

Russell said IVCCD closely partners with local industries and students participate in internships with industries around the state. Currently the college is working on creating new industry partnerships to meet the needs of the growing ethanol industry. The college is currently applying for ACE grant funds to expand its biotechnology program into the area of renewable energy. Dilip Dias, ECC biotechnology instructor, reported that the college is looking into starting vocational courses in molecular biology, protein technologies, and ethanol production processes. These efforts are in the planning stages and will not start for at least one more year, he said. Additionally, NSF funds are being sought to expand the college's biotech program and its partnerships with K-12 institutions.

A laboratory technology program (career option/college parallel) is also offered at Ellsworth, exposing students to opportunities in food technology, agriculture technology, pollution control technology, and chemical technology. Graduates of the program are expected to work as production technicians, research technicians, quality control technicians, pollution control technicians, technical service personnel, and related supervisory positions. Students are given the option of specializing in biotechnology, veterinary assistant, agriculture technology, chemical technology, and environmental technology.

Other programs potentially of interest include a number of two-year agriculture and health related degrees (both AA and AS programs) and transferable biology/chemistry courses.

**Iowa Lakes Community College (ILCC)** is currently planning to offer new bioscience related programs for the 2005-2006 academic year. Among these programs are biomass energy processing and sustainable energy resources management. The biomass energy processing program will initially include instruction in the ethanol production industry. Students will be instructed to use the latest techniques for producing alternative fuels such as ethanol and soy diesel. The Emmetsburg-based program may later be expanded to include other fuels such as methane and hydrogen. Emmetsburg Executive Dean Tom Brotherton reported the focus of the program is on operational knowledge and skills (electrical/mechanical/computer control). The program and curriculum were designed with the help of industry representatives and all students will participate in internships (subsequently the curriculum contains far more industry-oriented technical courses than science/theory courses). Brotherton said it is likely that instructors will be shared between industry and the biomass program. Additionally, career academy opportunities are being planned for on-campus delivery.

The sustainable energy resources management program is a two-year career option program designed to train managers for renewable energy businesses and industries. An extension of the college's wind energy program, it will incorporate a number of courses offered in the previous academic year. Students enrolled in the program will complete an internship for credit at one of many sustainable and renewable energy enterprises. NSF funding is being sought for the program to disseminate knowledge and create (re)training opportunities.

Brotherton said the growth in enzyme technology is affecting agriprocessing and will need to be expanded in the future. Non-credit courses are also being considered.

Recently, Iowa Lakes resubmitted a NSF grant proposal for development of an Animal Genomics program to blend the large animal experience available at the college's farm with the biotechnology and tissue culture skills increasingly common in both plant and animal production. If the college is awarded the grant, Brotherton said training sessions would be held for both area high school teachers and students.

Other programs potentially of interest include agriculture and health related programs. While most, if not all, community colleges offer transfer courses in biology or chemistry, ILCC and a handful of others go a step further by creating AA programs (or focus areas) for these fields. The colleges also vary on the level of science courses offered – some such as IHCC offer fairly advanced courses while others such as SWCC offer only basic survey courses.

**Kirkwood Community College (KCC)** has thus far opted to train students seeking four-year degrees in biotechnology by developing and offering a transfer biotechnology program. Students completing the program transfer to four-year institutions with B.S. programs in biology with emphases in biotechnology.

The transfer program was created eight years ago in collaboration with regional biotechnology and bioprocessing companies, Kirkwood Mathematics and Science Dean Bob Driggs reported. As a result of ongoing discussions with industry, Kirkwood will be developing additional programs of study. The new biotechnology-related programs of study will lead to AS and AAS degrees, diplomas, and certificates of completion, Driggs said. Significant numbers of technicians trained in basic laboratory skills and more advanced techniques in forensics, medical, quality control, and biotechnology labs are increasingly needed by regional industry. Additionally, technicians trained to monitor and control bioprocesses (e.g. fermentation used in ethanol production) are in demand. Driggs said the demand appears to significantly outstrip the current production rate of graduates in nearby programs such as the bio-processing program at IHCC and the medical technology program at the University of Iowa. While the nature of the new programs has yet to be determined, options will likely include crop genetics, animal genetics, fermentation, medical technology, forensics, and quality control. New courses will be added to the existing core of science and agriculture courses.

Kirkwood is managing several National Science Foundation grants to support work in the biosciences. Two grants, in particular, are of interest. The first is a multi-million dollar grant to create and operate AgrowKnowledge, the National Center for Agriscience and Technology Education. The center is a national partnership of community colleges with business and industry, leading universities in agriculture education, secondary schools, and professional associations. Driggs said AgrowKnowledge understands the increasing demand for high-tech careers in such areas as biotechnology, alternative energy production, precision agriculture, natural resource management, and nutritious food production. As a result, AgrowKnowledge partners better prepare students to use emerging technology.

The second NSF grant is a \$500,000 STEP grant to increase the number of students majoring in Science, Technology, Engineering, and mathematics (STEM). Partners include Kirkwood, public schools in the Cedar Rapids/Iowa City metro area, Grant Wood AEA, Women in Science and Engineering (WISE), and local industry.

Grant activities are supporting the creation of seamless STEM pathways from high schools to area colleges and universities. High schools will use Career Edge Academies to recruit, support, and motivate students to pursue STEM majors in college. Students will explore future career possibilities, academic programs, and personal characteristics needed for success. The program will also engage high school teachers in professional development opportunities. Five metro schools have joined in the discussions so far (with plans to create science academies by 2006-2007), but Driggs expects additional schools to be added as supplemental funds become available. Future STEM academies may include biotechnology, engineering, pre-medical professional, environmental science, and forensic science. Dual credit will be an option for students who wish to get early exposure to specific disciplines not currently part of the high school curriculum. Such courses may include microbiology, introduction to biotechnology, or Project Lead the Way pre-engineering courses. The new Career Edge Academies will compliment existing 2+2 programs in several applied science fields of study, Driggs reported.

Other programs potentially of interest include environmental technology (college parallel), water quality and wastewater technology (career, articulated), various health programs (including career academies), and continuing education courses.

**Southeastern Community College (SCC)** offers a biological science curriculum (including chemistry, organic chemistry, biology and microbiology courses) for AA students and allows emphases in biotechnology, clinical lab science, botany, microbiology, and zoology. AA students may also take a chemistry or medicine curriculum before transferring to four-year institutions. SCC also provides a biomedical option with its two-year electronics technology program. The program provides students with theoretical and practical skills needed for an entry-level electronics technologist position. Transfer plans exist to provide students the option to further their studies at Iowa State University (BS industrial technology program), University of Northern Iowa (BA technology management), or Western Illinois University (BS manufacturing engineering technology).

Southeastern Community College and Carl Sandburg Community College have a reciprocal agreement to permit Iowa students to attend classes at Carl Sandburg and Illinois students to attend courses at SCC at in-district, resident tuition rates. This allows SCC students access to several radiological technology programs (with focus areas of magnetic resonance imaging, CT, and diagnostic medical sonography).

SCC West Burlington Campus Executive Dean Curtis Blom reported the college is not considering developing any new bioscience programs but may partner with IHCC sometime in the future. Such an arrangement would allow SCC students to take part in IHCC biotechnology-related programs.

Other programs potentially of interest include nursing/health (including several medical-related AA transfer programs) and agriculture programs (including veterinary medicine) as well as biology/chemistry transfer courses. Blom also noted SCC offers a number of grade-level career days for K-12 students.

**Iowa Western Community College (IWCC)** offers biological sciences and chemistry AA programs. Students completing the programs are expected to transfer their credits to similar life sciences programs at four-year institutions. The curricula consist primarily of biology, chemistry, anatomy/physiology, physics and math courses (i.e. not career-oriented technical courses), Dean of Health, Biological, and Sports Sciences

Becky Burgart reported. A microbiology transfer (AA) program is also offered providing students with the opportunity to take their first two years of a four-year microbiology program at IWCC before transferring to Iowa State University.

Burgart noted IWCC has participated in a Girl Scout initiative aimed at getting more females interested in pursuing careers in science. The college also holds health/science career days for students interested in those fields.

Other programs potentially of interest include forensic investigation (associate and certificate programs) as well as agriculture (e.g. veterinary technology) and health programs. While IWCC is in the process of developing career academies with local high schools, they are not focused on bioscience.

**Eastern Iowa Community College District (EICCD)** is currently investigating programs in biotechnology and bioprocessing. EICCD Chief Academic Officer Jeff Armstrong reported that two proposals are currently in the works – one with the National Science Foundation (NSF) for a biotechnology certificate program and the other as part of a Department of Labor proposal for a bioprocessing degree program. The certificate program would provide students with basic laboratory skills and some bioprocess control training. The AS degree program would provide bioprocessing skills needed by area industries such as GPC and Monsanto but would likely be more general (less fermentation-focused) than IHCC's program. If grant funding is received, the programs will likely be housed in the new 37,000 square foot John T. Blong Technology Center (home to a number of industry-oriented credit and noncredit classes and programs) in Davenport.

EICC closely partners with high schools to provide students additional opportunities. The college partners with Mississippi Bend AEA and 20 high schools in the Eastern Iowa Agriculture Learning Cooperative. The cooperative facilitates program articulation and professional development for high school ag. teachers. Armstrong noted that a biotechnology workshop would be offered in the future, possibly in conjunction with Monsanto. Additionally, Project Lead the Way, a pre-engineering program, has recently expanded to more high schools and several 2+2 career academies have been developed in areas such as health.

Through a NSF Grant received by EICCD, the NewVentures AgTech Initiative was created to investigate emerging technologies and evaluate their potential for local commercialization. Collaborating with the NewVentures Initiative, a privately-funded non-profit organization dedicated to accelerating the startup of tech-driven companies, they hope to make eastern Iowa a hub for innovation by connecting entrepreneurs with capital, markets, and business expertise.

Other programs potentially of interest include biology/chemistry transfer courses, agriculture and health programs, and the health, safety, and environmental technology program. EICC has served as the home for the NSF-funded Advanced Technology Environmental Education Center (ATEEC) for the past 11 years.

**Northeast Iowa Community College (NICC)** offers science and math courses that may be transferred to four-year institutions. An introduction to biotechnology course is also offered (focusing on DNA-related emerging technologies), however it is infrequently scheduled due to low interest. NICC Vice President of Economic Development Services Ken Vande Berg reported that there have been discussions about



moving forward with a biotechnology-related program within the next year (potentially with a related career academy).

NICC Dean of Industrial Technology, Mathematics, Science, and Computer Science David Clark reported the college offers several agriculture courses that involve biotechnology including agriscience, animal genetics, animal breeding and reproduction, artificial insemination, swine reproduction and management, and dairy nutrition. The college also offers enology and viticulture programs involving cultivar selection, fermentation, and other related processes through its partnership in the VESTA consortium. Additionally, NICC offers several health programs that may be of interest including an electroneurodiagnostic technology program (AAS) that trains students to work as technologists recording electrical activity in the brain/spinal cord/etc. Students are expected to find employment in hospitals, clinics, and research centers (e.g. epilepsy and sleep centers). Health career academies have been created through partnerships between NICC and several area high schools. Other programs potentially of interest include a medical lab technician program and other health programs.

**Southwestern Community College (SWCC)** offers chemistry, biology, math and other bioscience-related courses but currently does not have any bioscience/biotechnology program. SWCC Vice President for Instruction Chris Duree said the college does, however, offer a course in biotechnology.

SWCC has also made investments in science facilities to support courses in chemistry and biology but this was done primarily to enhance required courses for the nursing program. Related programs potentially of interest might include “traditional” agriculture and health programs though course offerings are more limited than at larger colleges.

**North Iowa Area Community College (NIACC)** intends to build off of its strengths in manufacturing technologies and biology by creating a bioprocessing technology specialization within its industrial technology AAS degree program. This program will be designed to support the needs of multiple local biotechnology manufacturing companies in the areas of ethanol production and animal pharmaceuticals. Students will take a core of courses in manufacturing fundamentals, such as manufacturing processes, fluid power, and electrical concepts, before taking courses in their emphasis area of bioprocessing technology. The bioprocessing component of the program will be taught by an industry expert, NIACC Industrial Technology Division Chair John Sjolinder reported.

To prepare students wishing to transfer to four-year bioscience programs, NIACC offers a strong biology curriculum. In addition, NIACC students may transfer into Indian Hills Community College’s bioprocessing program or the medical laboratory technician program at Hawkeye Community College.

NIACC’s continuing education division is involved with training at the Golden Grain ethanol plant in Mason City and the Iowa Ethanol plant in Hanlontown. Thus far, the training has focused on the improvement of plant operations and financial performance through the application of lean manufacturing processes and courses in plant and equipment maintenance.

With strong K-12 partnerships, NIACC has attempted to ensure that students receive a solid foundation in science before they enter college and that teachers are prepared to provide that background. NIACC is helping to prepare elementary school

teachers for math and science instruction. Additionally, the college participated in an NSF-funded project to strengthen math and science teacher preparation. During the 2005-2006 academic year, math and science faculty at NIACC will pilot a learning community that combines math and science instruction for elementary school teachers. The college also delivers college-level science courses at area high schools through its school partnership program.

Other programs potentially of interest include agriculture and health programs. NIACC's agriculture curriculum includes bioscience applications such as embryo transfers in cattle, piloting genetically modified crops, the use of gene marker technology, and more. During the 2005-2006 academic year, the curriculum will incorporate new bioscience exploratory labs (e.g. green fluorescent protein chromatography). Additionally, the college's agriculture division recently co-sponsored several workshops with Iowa State University to expose producers and students to biotechnologies. NIACC also offers health programs and health career academies with local school districts.

**Northwest Iowa Community College (NCC)** offers transferable introductory chemistry and biology courses. Dr. Rhonda Pennings, NCC Dean of Arts and Sciences/Business/Health, reported that college is investigating offering a biotechnology credit program (probably a laboratory technician program with options for emphases in either medical or ethanol areas), but currently no bioscience programs or courses are available and planning for the new program is in its early stages. However, some general science courses (e.g. microbiology, biology, chemistry) have biotechnology or related units within them, Pennings noted.

The NCC Business and Industry Center, in partnership with the Iowa Corn Promotion Board, created the Ethanol Technical Servicing Project in 1996. The project attempts to expand the use of ethanol through educational activities. The college has also offered training opportunities for area ethanol businesses on a case-by-case basis. In the future, NCC may partner with IHCC to offer continuing education courses to area ethanol companies.

Other programs potentially of interest include agriculture and health programs. Additionally, continuing education training is held annually for water and wastewater system operators.

### **Community College faculty involved in bioscience education**

While instructors in bioscience fields are in high demand (especially in technical areas), Iowa's community colleges have been able to attract talented faculty, often with doctorate degrees. For instance, at WITCC, three science department staff members have PhDs. The following are brief biographies of some of the college faculty involved in bioscience instruction at community colleges.

**Jane Bradley**, Chair of the Biotechnology Program at DMACC, is a Ph.D. candidate at Texas A & M University and has done graduate work in Biochemistry and Biophysics at the University of Oklahoma. She began her post-secondary education at Seminole Junior College in Oklahoma where she received her A.S. Bradley has previously worked as a biology instructor at Seminole State College in Oklahoma and as a lab manager at the Oklahoma State University College of Veterinary Medicine.

**Dr. Dilip Dias**, biotechnology instructor at Ellsworth Community College (IVCCD), is from Sri Lanka where he received a BS degree in agriculture from the University of Peradeniya, Sri Lanka. He came to the United States in 1985 and attended the University of Houston where he received his Masters degree. He continued his education at Texas A & M University and earned his Doctorate in Plant Physiology and Plant Biotechnology. He later worked as a scientist studying how plants tolerate drought stress before moving to Iowa in 1996 to take a position with Garst Seed Co. Dr. Dias joined the Ellsworth Community College faculty in December 2004.

**Dr. Patrick Galliard**, chair of the Natural Science Division and instructor of biological sciences at NIACC earned his M.S. and Ph.D in Zoology at Iowa State University. Since 1993, he has taught biological science courses at the college. Dr. Galliard has authored several scientific papers on insect behavioral ecology in peer-reviewed journals, instructor's manuals for anatomy and physiology textbooks, and a laboratory manual for anatomy and physiology labs.

**Dr. Paul Mayes**, Department Coordinator of Science and Math at EICC, earned his Ph.D. in higher education and zoology from the University of Iowa in 1992. He has been involved with biotechnology education and staff development for middle and high school teachers since 1993. Dr. Mayes has also served as an instructor for Project BIO and Iowa State University's Biotechnology Program (including outreach efforts such as professional development for K-12 teachers).

**Dr. Kamali Muthukrishnan**, Department Chair of Science at WITCC, earned her Ph.D. in Bioscience from the Indian Institute of Technology in Madras, India in 1980. She received postdoctoral training at the University of Texas M. D. Anderson Cancer Center and University of Texas Medical School in Houston, Texas. She had also worked as the equipment coordinator for the Department of Biochemistry and Cell Biology at Rice University in Houston, Texas and with the University of Texas Southwestern Medical Center in Dallas, Texas. Dr. Muthukrishnan has been a faculty member with WITCC since 1998.

**Dr. Byron Olson**, Project Coordinator for the Biotech Model Project at the IHCC Iowa BioProcess Training Center, earned his Ph.D. in Bioengineering from Arizona State University and had received a B.S. in mathematics from Iowa State University. Dr. Olson has worked in industrial pharmaceutical research and has taught at both the secondary and postsecondary levels.

**Michael Ott**, Director of Iowa BioDevelopment at IHCC, earned his master's degree in Bioinorganic Chemistry from the University of Iowa (with research in the area of metal activity in peroxidase enzymes). Ott's previous work experience has primarily dealt with finance in biotechnology in both public and private markets.

**Dr. Greg Romig**, Instructor in Biology at WITCC, earned his D.A. (Doctor of Arts) in Biology from the University of North Dakota. His previous teaching experience was at

the Minnesota Academy of Mathematics and Science in Winona, Minnesota. At WITCC, Dr. Romig teaches Nutrition, Anatomy and Physiology, and Genetics.

**Dr. Renee Romig**, Instructor of Chemistry and Biology at WITCC, earned her Ph.D. from the University of Nebraska Medical Center where she was a student at the Eppley Cancer Research Training Program in the Department of Biochemistry and Molecular Biology. She has over five years of high school and college teaching experience and has been teaching at WITCC since the fall of 2000. Prior to 2000, Romig taught at the Minnesota Academy of Mathematics and Science in Winona, Minnesota where she served as the Biochemistry instructor and later Director of Academics and Student Affairs. At WITCC, she teaches Nutrition, Organic Chemistry, Biochemistry, Biotech I (Genomics), Biotech II (Proteomics), and Issues in Biotechnology.

**Dr. Suresh Tiwari**, Dean of Arts and Sciences at HCC, earned his Ph.D. in Developmental Biology at the Australian National University in Canberra, Australia. Prior to becoming actively involved with community colleges, Dr. Tiwari was engaged in scientific research in cell, developmental, and molecular biology for over 15 years. He has authored over thirty scientific papers, invited reviews, and book reviews published in peer-reviewed, national and international journals. He is an active member of numerous professional organizations and has taught or worked as a researcher at numerous colleges and universities on four continents.